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TiO₂ ASSISTED PHOTO-OXIDATIVE PRETREATMENT OF WHEAT STRAW FOR BIOGAS PRODUCTION

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Photo-catalytic oxidation is an advanced oxidation process in which a catalyst is used to absorb light energy and oxidize the target substrates such as organic polymers. A number of metal oxides and metal ions can efficiently increase substrate's depolymerisation during the process of photo-catalytic oxidation. Titanium oxide (TiO₂) is a photo-catalyst that in its rutile and anatase forms presents the property to enhance the photo-oxidation of lignin-containing substrates. Due to lignin is one of the major obstacles in methane production from lignocellulosic biomass, its destruction is a necessary step to enhance biomass biodegradability in anaerobic digestion (AD) process. Thus, the present study elucidated the photo-catalytic oxidation of highly lignified wheat straw using TiO₂ at the presence of UV light in the region of 300-360nm. Specifically, the combinations of four different concentrations of TiO₂ (i.e. 0.5, 1, 1.5 and 2 wt%) with four different exposure time periods (i.e. 0, 60, 120 and 180 min) were investigated under 700W medium pressure UV lamp radiations. Subsequently, biochemical methane potentials (BMPs) assays were conducted under thermophilic conditions for the different pretreated samples, based on the guidelines of the BMP protocol. The results showed that the methane yield was increased by 27% ($p < 0.05$) when compared to untreated wheat straw, due to the action of pretreatment with 1.5 wt% TiO₂ at 180min of exposure time. The findings were in accordance with the scanning electron microscopy (SEM) images of the pretreated wheat straw that showed augmented damaged areas and development of pits after the pretreatment. In addition, the products of oxidation were also measured, as it was expected the lignin to be oxidized into phenolic acids. For instance, vanillic acid was found to be markedly higher in the pretreated samples that were exposed for 180min with 1.5 wt% and 2 wt% of TiO₂ compared to the untreated wheat straw. Moreover, it was concluded that the products of lignin oxidation and also, the presence of TiO₂ did not inhibit the AD process. Finally, UV treatment or TiO₂ alone did not enhance the decomposition of wheat straw and the methane production from these samples did not differ significantly compared to untreated biomass ($p > 0.05$).